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1.	Your reference	P15296
2.	Patent application number *(The Patent Office will fill in this part)*	**0010979.3**
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	1) VARINTELLIGENT (BVI) LIMITED 6667612001 CRAIGMUIR CHAMBERS, P.O. BOX NO. 71, ROAD TOWN, TORTOLA, BRITISH VIRGIN ISLANDS 2) TERENCE LESLIE JOHNSON C/O EDWARD EVANS & CO. CLIFFORD'S INN, FETTER LANE, 4392130002 LONDON EC4A 1BX
	Patents ADP number *(if you know it)*	
	If the applicant is a corporate body, give the country/state of its incorporation	1) BRITISH VIRGIN ISLANDS 2) UNITED KINGDOM
4.	Title of the invention	A DRIVING SCHEME FOR LIQUID CRYSTAL DISPLAYS
5.	Name of your agent *(if you have one)* "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Edward Evans & Co. Clifford's Inn Fetter Lane London EC4A 1BX
	Patents ADP number *(if you know it)*	661001
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country / Priority application number *(if you know it)* / Date of filing *(day / month / year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application / Date of filing *(day / month / year)*
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Continuation sheets of this form	
Description	4
Claim(s)	-
Abstract	-
Drawing(s)	14 + 14

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Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
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11. I/We request the grant of a patent on the basis of this application.

Signature Edward E

Date 05.05.00

12. Name and daytime telephone number of person to contact in the United Kingdom TERRY L. JOHNSON 0207 405 4916

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A DRIVING SCHEME FOR LIQUID CRYSTAL DISPLAYS

Summary of the Present Invention

The present invention is related to passively and actively driven liquid crystal display, or more particularly to the driving of the said display to minimize perception of flickering effect to observer. In the present invention, a multi-column/row/pixel inversion driving method is proposed which greatly reduces total fringe field effect on display to maintain the contrast, yet minimizing perception of flickering. The number of inversions can be adjusted to strike a balance between contrast and perceptibility of flickering.

Description of the Embodiment

Fig. 1 shows the structure of a passively driven liquid crystal display. Polarizers are attached on the outside of the glass substrates. The inner side of the glass substrates is coated with conductive Indium Tin Oxide (ITO) film whereon polyimide film is applied for alignment of the liquid crystal molecules. An enclosure between the glass

substrates is formed by epoxy glue wherein liquid crystal is filled. The structure of the display is symmetrical with respect to the liquid crystal layer. Matrix addressing scheme is then applied to the ITO electrodes for addressing individual pixel formed by the intersection of the ITO lines. Frame inversion is adopted to avoid net DC applied to the liquid crystal. Fig. 2 shows an example waveform applied to the common and segment electrodes. In this arrangement, flickering effect may still exist due to the fact that liquid crystal molecules are usually not perfectly non-polar. In this case, flickering effect can be minimized by adopting a high enough frame frequency. In some occasions, the arrangement of the liquid crystal display is not symmetrical. Fig. 3 shows another arrangement such that underneath the polyimide coating a coating of silicon dioxide is applied for the purpose of better electrical isolation between the two ITO surfaces. Fig. 4 shows another arrangement such that on the rear glass substrate/underneath the front glass substrate color filter material is applied on/under the ITO layer. Yet another arrangement Fig. 5 shows that reflective coating is applied on/under the ITO layer of the rear substrate. All these arrangement results in loss of symmetry of the display that results in imbalance of charge built up among the substrates. The imbalance consequently results in net DC and different effective signal waveform in two consecutive frames, which causes flickering. On the other hand, flickering is also observed in actively driven liquid crystal display where imbalance of charge is caused by the presence of color filter, amorphous silicon TFT, poly silicon TFT, etc on one of the two glass substrates. In the case of reflective single crystal CMOS microdisplay, one of the glass substrates is replaced by silicon die, causing even higher degree of imbalance. Fig. 6 shows the arrangement for reflective single crystal CMOS microdisplay. To solve the flickering problem caused by imbalance of effective signal waveform, row/column inversion was proposed for actively driven liquid crystal display such that the flickering effect is spatially averaged out to an extent that is imperceptible. Fig. 7, Fig. 8, and Fig. 9 show respectively the signal waveform incorporating row, column, and pixel inversion schemes. Fig. 10-12 show respectively the polarities of resulting fields applied to pixels for two consecutive frames adopting the row, column, and pixel inversion schemes. For passively driven liquid crystal displays, row inversion can be adopted to minimize the perception of flickering. Fig. 13 shows the signal waveform incorporating row inversion. In all cases, the inversion method results in reduced contrast due to fringe field effect occurring on the pixel boundary. The loss is negligible when the pixel size is not too small. However, in case of miniature display (e.g., amorphous-silicon TFT, poly-silicon TFT, and reflective CMOS miniature display), the loss of contrast can be severe and cannot be overseen. Fig. 14 shows the 2D director configurations of two pixels of 15umx15um driven in column inversion mode. In the present invention, a

multi-column/row inversion driving method is proposed which greatly reduces total fringe field effect on display to maintain the contrast, yet minimizing perception of flickering. The number of inversions can be adjusted to strike a balance between contrast and perceptibility of flickering. Fig. 15 shows the waveform with n-row inversion with n=2. Assuming that M is the number of scan lines. If n=M, we have conventional frame inversion. If n=1, we have single row inversion system. By increasing n, we have reduced fringing field effect but increased perceptibility of flickering. Similarly, Fig. 16, Fig. 17, and Fig. 18 show respectively the resulting polarities of field applied to pixels for multi-row, multi-column, and multi-pixel inversion system for actively driven liquid crystal display while Fig. 19. Fig. 20, and Fig. 21 show respectively the driving waveforms. The figures demonstrate the cases of 2-row, 2-column, and 2x2-pixel inversion schemes. For multi-pixel inversion scheme, the building blocks can be of order mxn where m and/or n greater than one for multi-pixel inversion scheme.

For reflective single crystal CMOS microdisplay, assuming pixel size of 10um, single column inversion results in reduction of contrast by 30%. The reduction of contrast is kept below 5% by adopting 4-column inversion while at the same time flickering is imperceptible.

Advantages

1 An m-column/n-row/nxm-pixel inversion driving method for liquid crystal display where m can be any integer from two to number of scan lines and n can be any integer from two to number of column lines. The driving method greatly reduces total fringe field effect on display to maintain the contrast, yet minimizing perception of flickering. The number of inversions can be adjusted to strike a balance between contrast and perceptibility of flickering.

2 The n-row inversion driving method can be applied to passively and actively driven liquid crystal display where n can be any integer from two to number of scan lines

3 The m-column inversion driving method can be applied to actively driven liquid crystal displays where m can be any integer from two to number of column lines

4 The *nxm*-pixel inversion driving method can be applied to actively driven liquid crystal display where *n* can be any integer from two to number of scan lines and *m* can be any integer from two to number of column lines

5 The inversion scheme is particularly advantageous to be adopted in actively driven miniature TFT and reflective liquid crystal on silicon displays where fringe field effect can be severe if conventional single row/column/pixel inversion scheme is adopted.

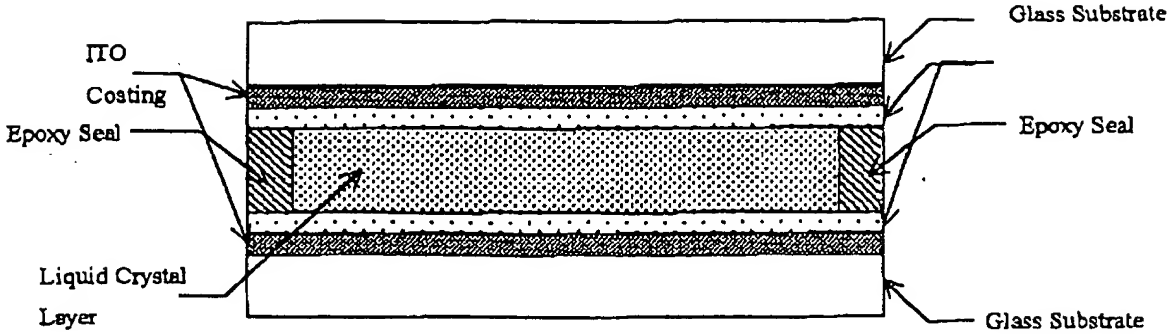

Fig. 1 Structure of passively driven liquid crystal display

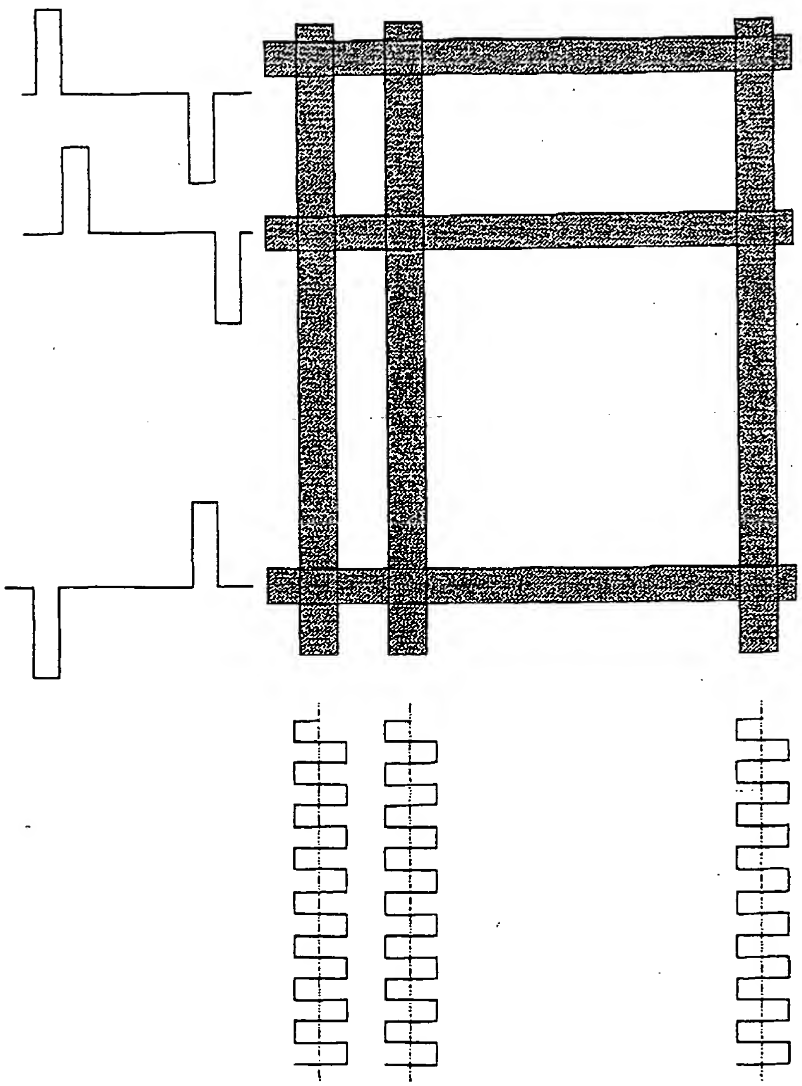

Fig. 2 Example waveform applied to the common and segment electrodes

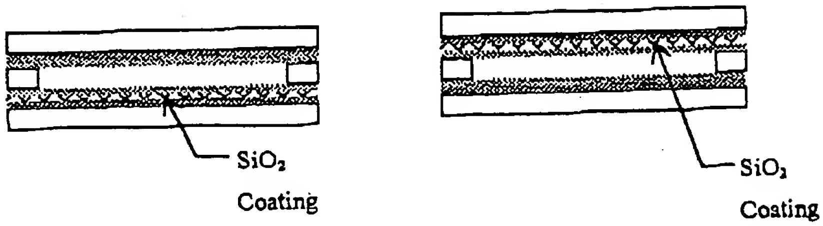

Fig. 3 Coating of silicon dioxide applied for better electrical isolation between the two ITO surfaces

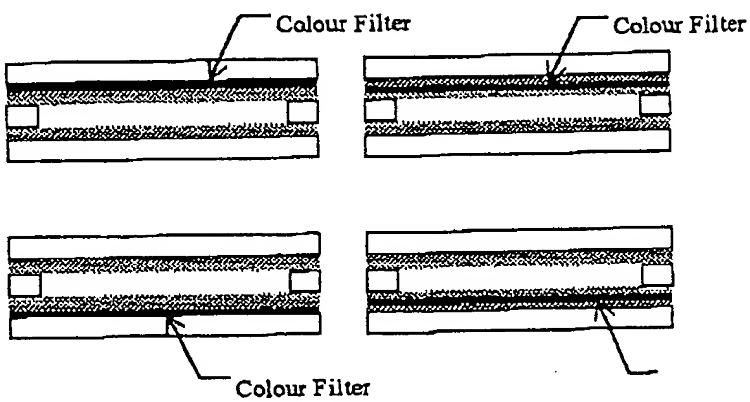

Fig. 4 Color filter material applied on/under the ITO layer

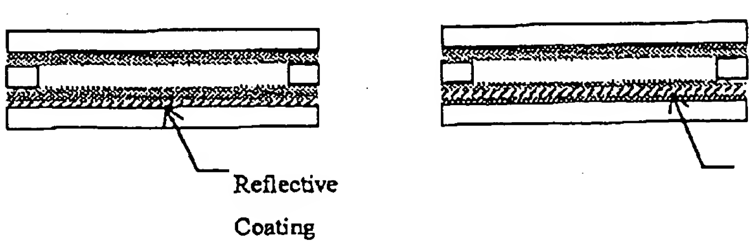

Fig. 5 reflective coating applied on/under the ITO layer of the rear substrate

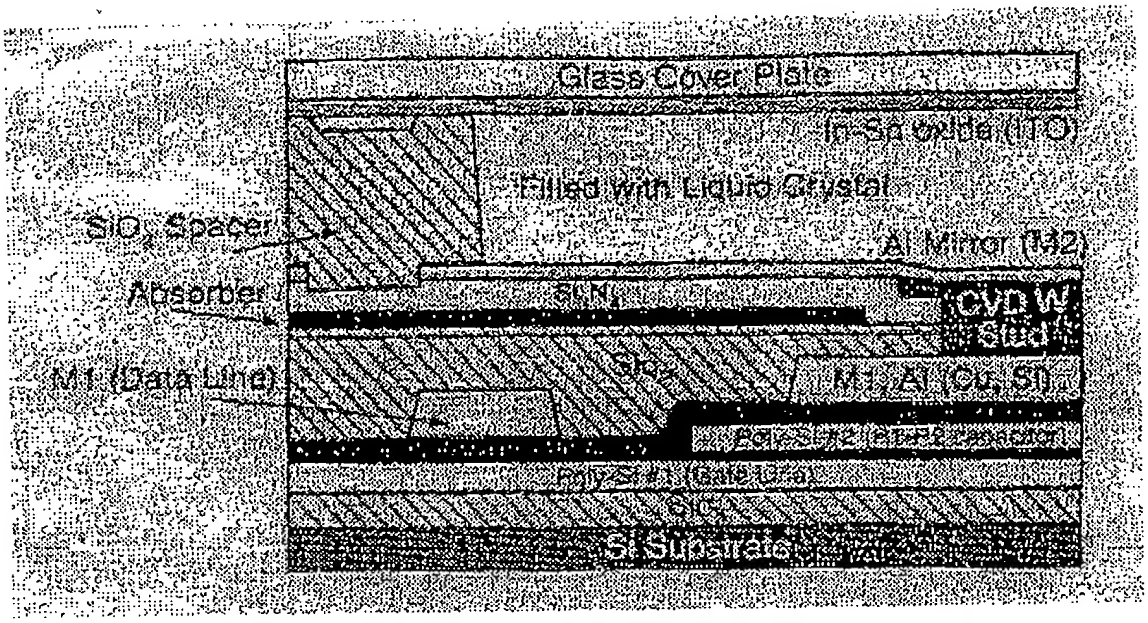

Fig. 6 Arrangement for reflective single crystal CMOS microdisplay

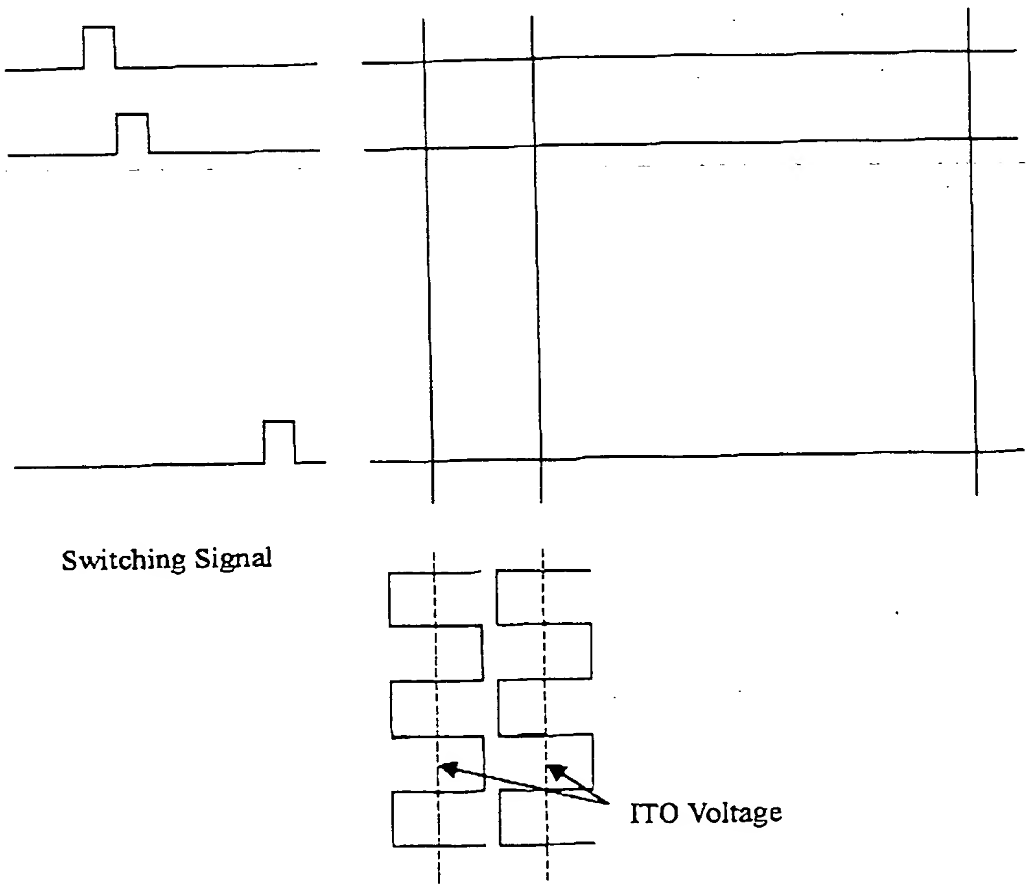

Fig. 7 Signal waveform incorporating row inversion scheme for actively driven liquid crystal display

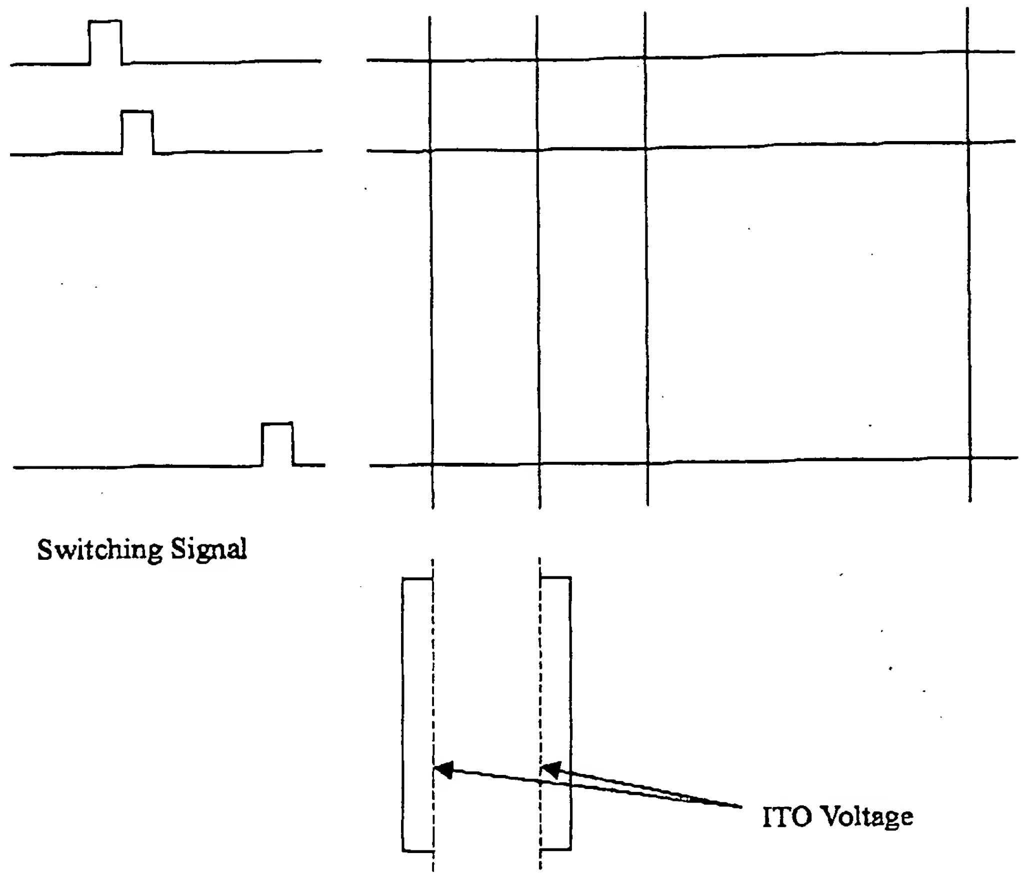

Fig. 8 Signal waveform incorporating column inversion scheme for actively driven liquid crystal display

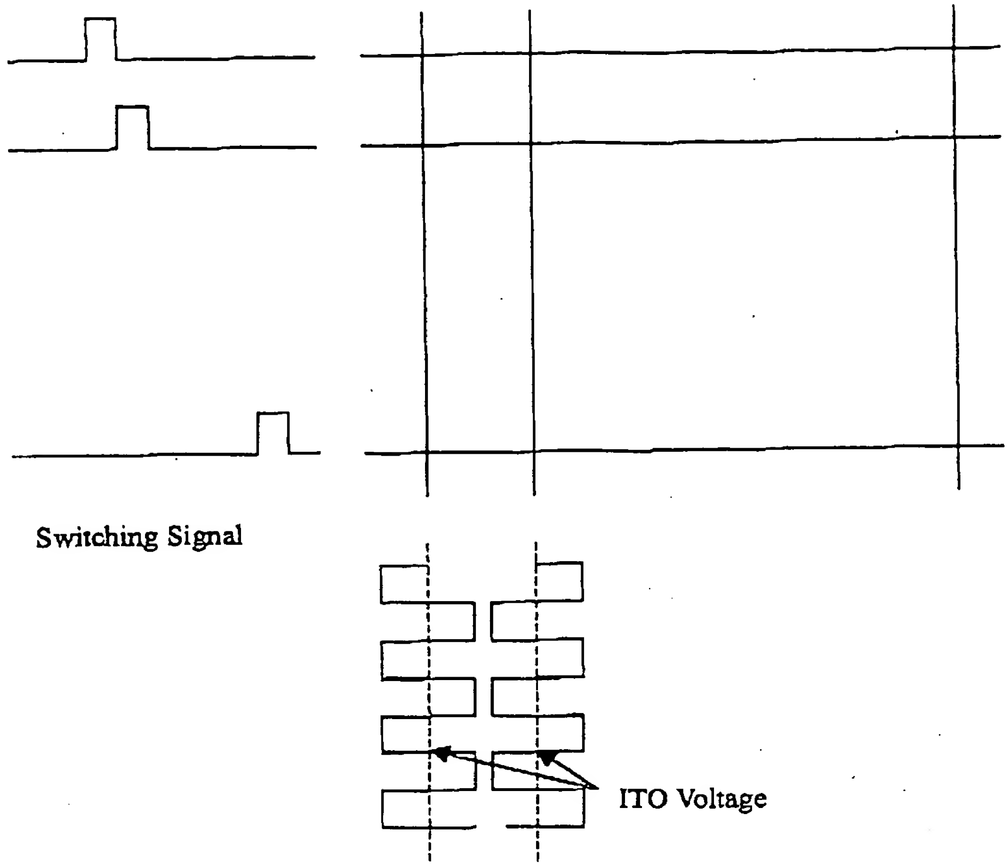

Fig. 9 Signal waveform incorporating pixel inversion scheme for actively driven liquid crystal display

+	+	+	+	+	+
-	-	-	-	-	-
+	+	+	+	+	+
-	-	-	-	-	-
+	+	+	+	+	+
-	-	-	-	-	-

Frame N

-	-	-	-	-	-
+	+	+	+	+	+
-	-	-	-	-	-
+	+	+	+	+	+
-	-	-	-	-	-
+	+	+	+	+	+

Frame N+1

Fig. 10 Polarities of resulting fields applied to pixels for two consecutive frames adopting row inversion scheme

+	-	+	-	+	-
+	-	+	-	+	-
+	-	+	-	+	-
+	-	+	-	+	-
+	-	+	-	+	-
+	-	+	-	+	-

Frame N

-	+	-	+	-	+
-	+	-	+	-	+
-	+	-	+	-	+
-	+	-	+	-	+
-	+	-	+	-	+
-	+	-	+	-	+

Frame N+1

Fig. 11 Polarities of resulting fields applied to pixels for two consecutive frames adopting column inversion scheme

+	-	+	-	+	-
-	+	-	+	-	+
+	-	+	-	+	-
-	+	-	+	-	+
+	-	+	-	+	-
-	+	-	+	-	+

Frame N

-	+	-	+	-	+
+	-	+	-	+	-
-	+	-	+	-	+
+	-	+	-	+	-
-	+	-	+	-	+
+	-	+	-	+	-

Frame N+1

Fig. 12 Polarities of resulting fields applied to pixels for two consecutive frames adopting pixel inversion scheme

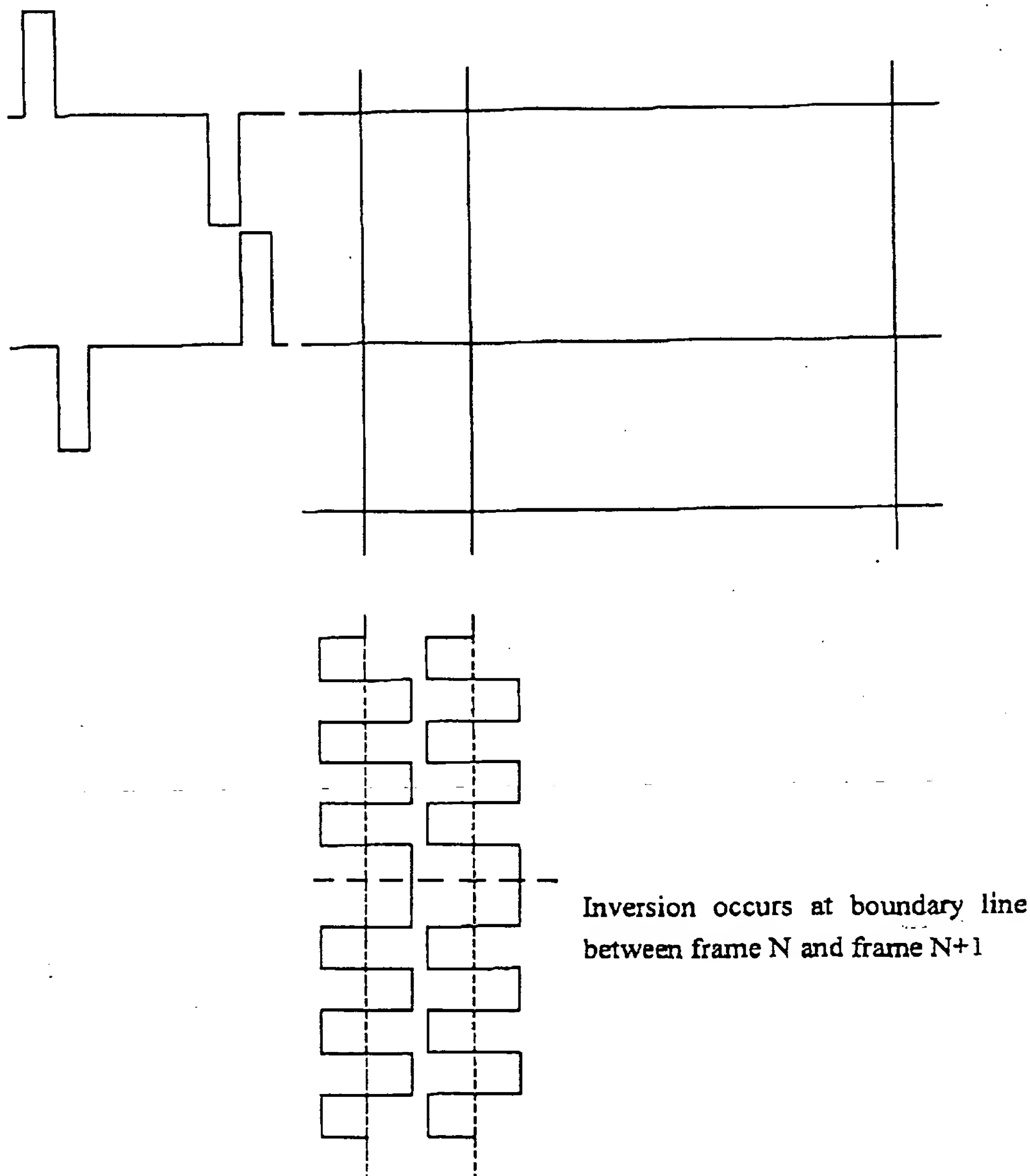

Fig. 13 Signal waveform incorporating row inversion scheme for passively driven liquid crystal display

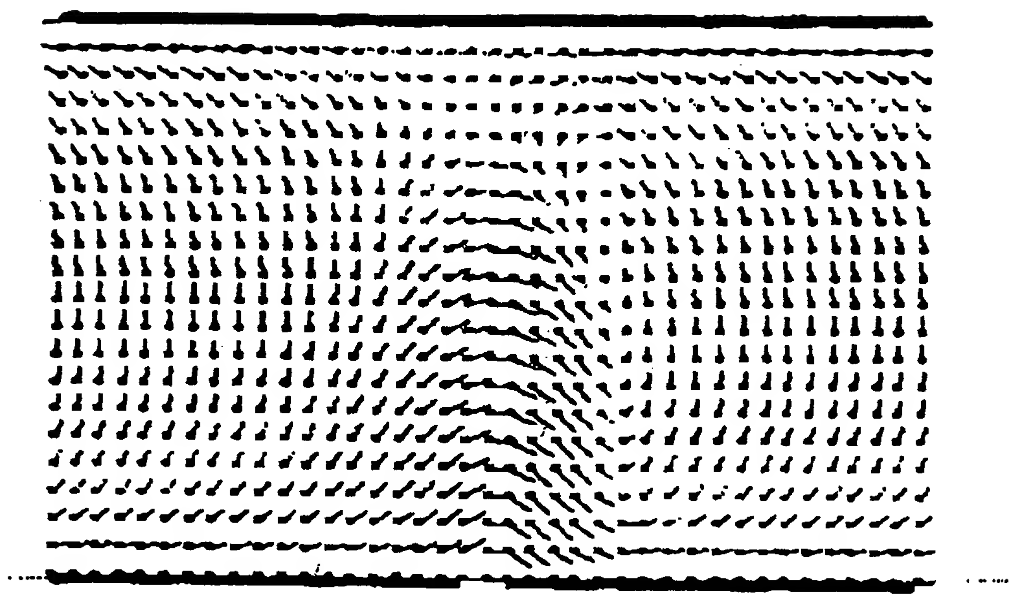

Fig. 14 2D director configuration of two pixels driven in column inversion mode

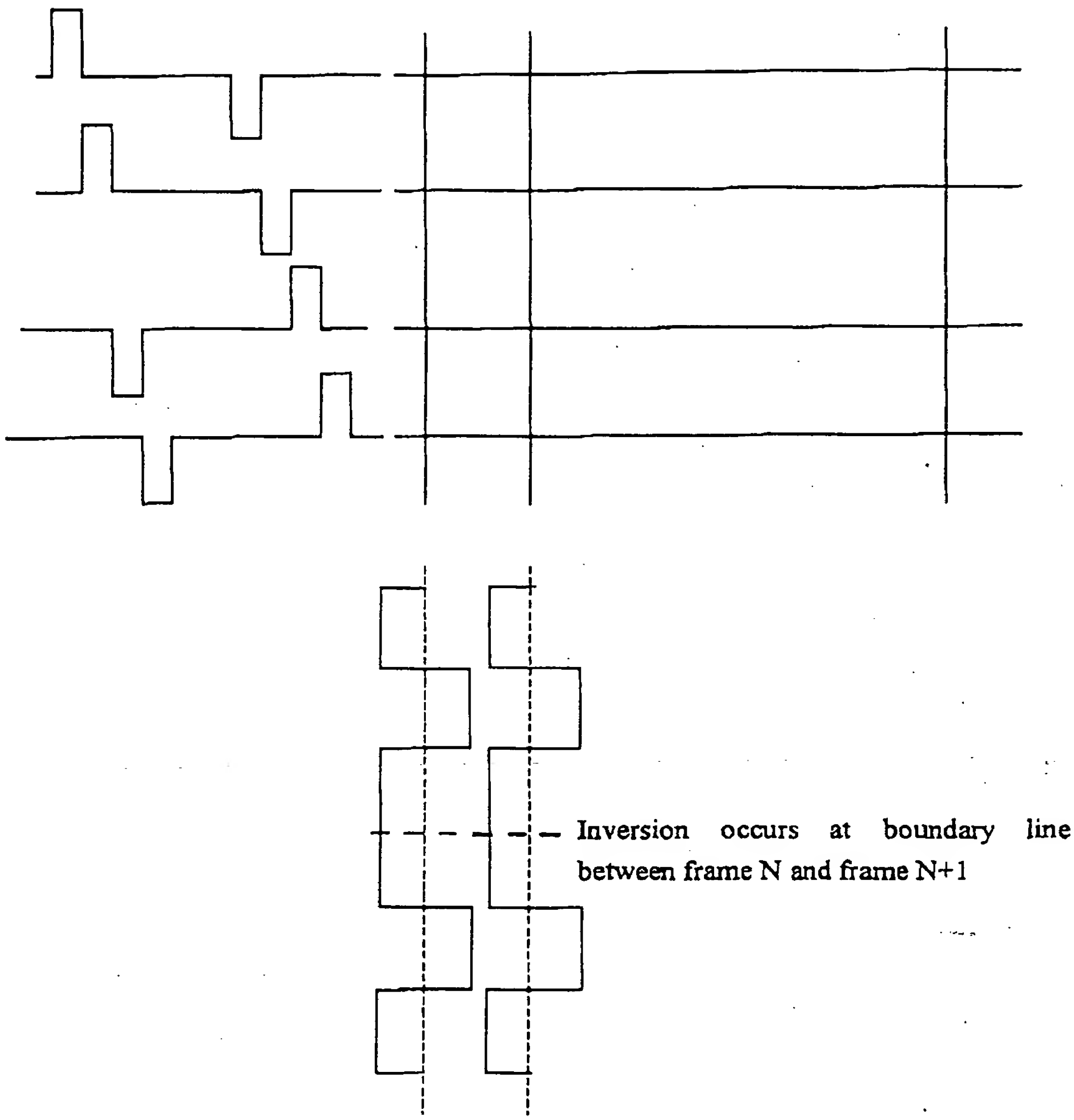

Fig. 15 Signal waveform incorporating 2-row inversion scheme for passively driven liquid crystal display

+	+	+	+	+	+
+	+	+	+	+	+
-	-	-	-	-	-
-	-	-	-	-	-
+	+	+	+	+	+
+	+	+	+	+	+

Frame N

-	-	-	-	-	-
-	-	-	-	-	-
+	+	+	+	+	+
+	+	+	+	+	+
-	-	-	-	-	-
-	-	-	-	-	-

Frame N+1

Fig. 16 Polarities of resulting fields applied to pixels for two consecutive frames adopting 2-row inversion scheme

+	+	-	-	+	+
+	+	-	-	+	+
+	+	-	-	+	+
+	+	-	-	+	+
+	+	-	-	+	+
+	+	-	-	+	+

Frame N

-	-	+	+	-	-
-	-	+	+	-	-
-	-	+	+	-	-
-	-	+	+	-	-
-	-	+	+	-	-
-	-	+	+	-	-

Frame N+1

Fig. 17 Polarities of resulting fields applied to pixels for two consecutive frames adopting 2-column inversion scheme

+	+	-	-	+	+
+	+	-	-	+	+
-	-	+	+	-	-
-	-	+	+	-	-
+	+	-	-	+	+
+	+	-	-	+	+

Frame N

-	-	+	+	-	-
-	-	+	+	-	-
+	+	-	-	+	+
+	+	-	-	+	+
-	-	+	+	-	-
-	-	+	+	-	-

Frame N+1

Fig. 18 Polarities of resulting fields applied to pixels for two consecutive frames adopting 2x2-pixel inversion scheme

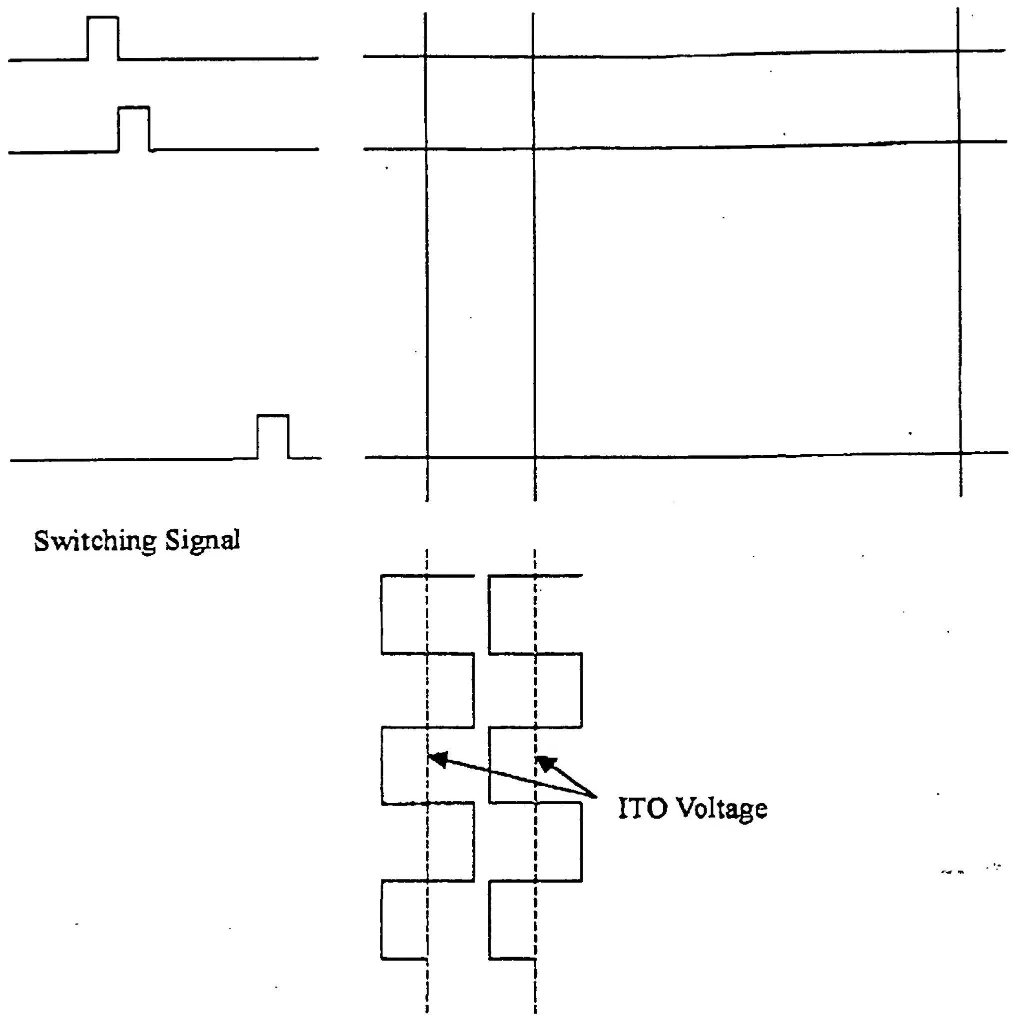

Fig. 19 Signal waveform incorporating 2-row inversion scheme for actively driven liquid crystal display

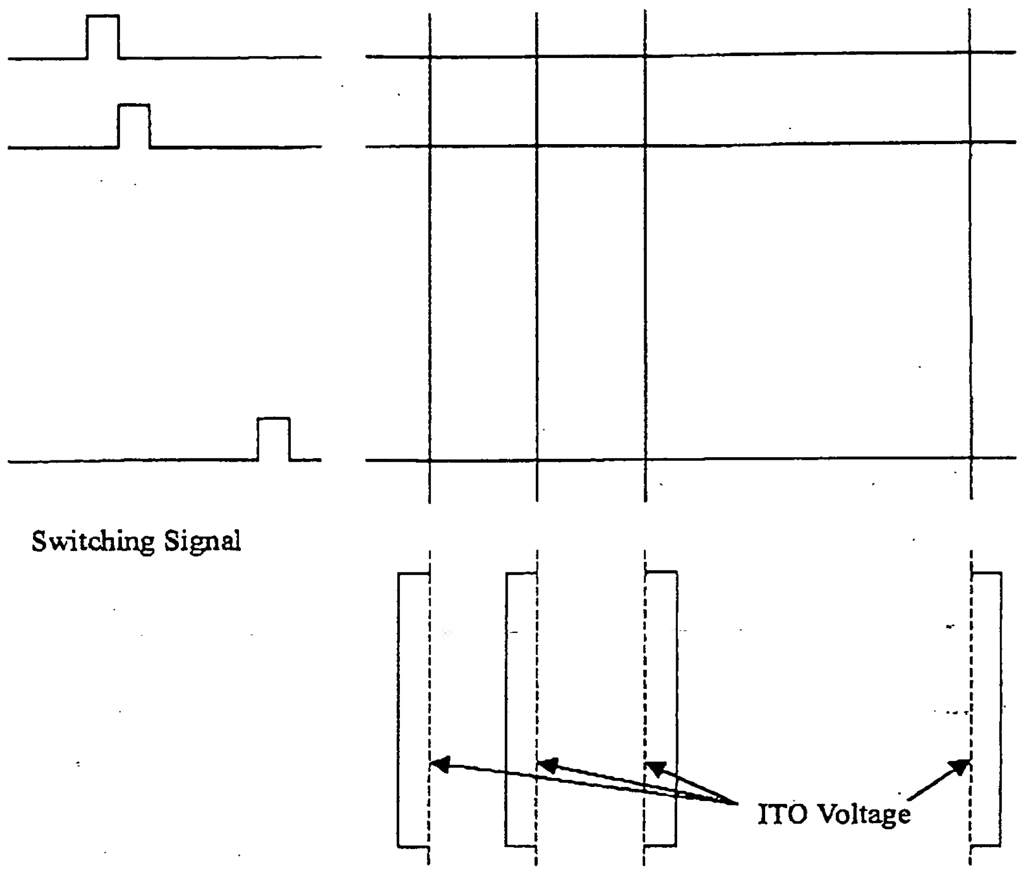

Fig. 20 Signal waveform incorporating 2-column inversion scheme for actively driven liquid crystal display

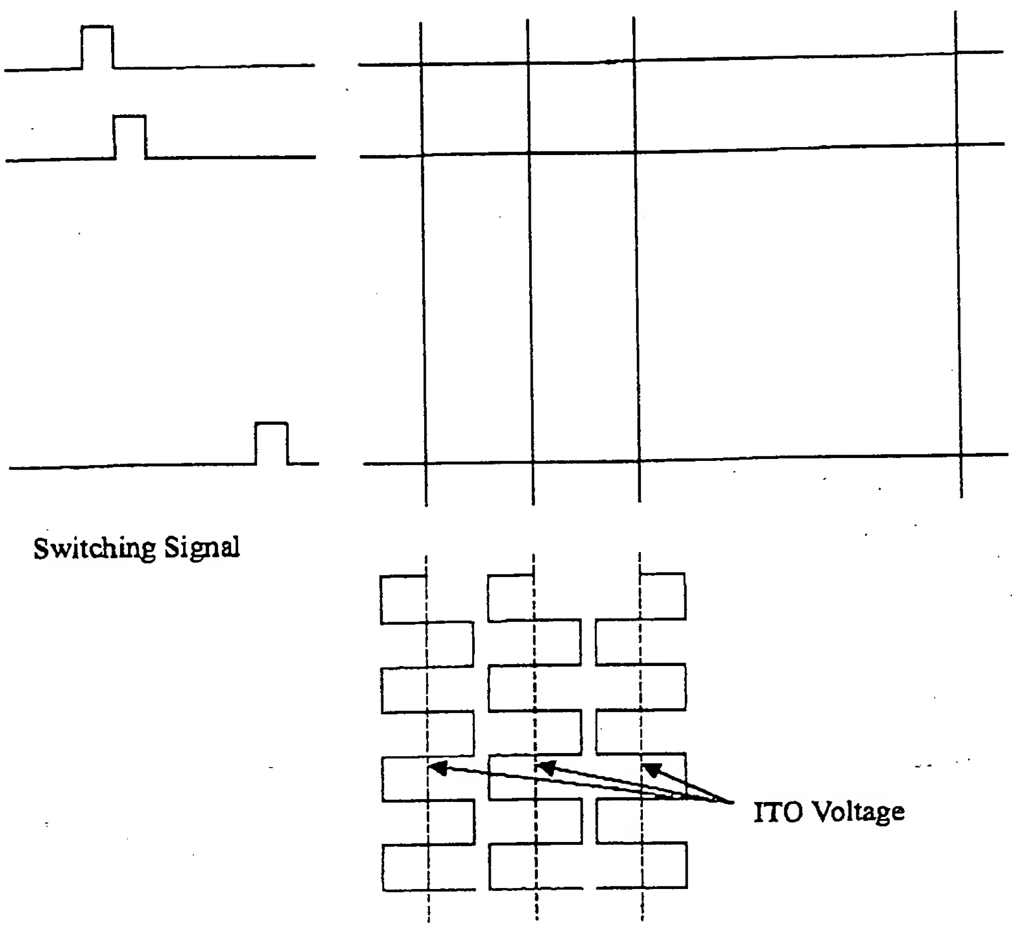

Fig. 21 Signal waveform incorporating 2x2-pixel inversion scheme for actively driven liquid crystal display